Balsam Lake
Fisheries Assessment, 2014-2015
Polk County, WI

(MWBIC: 2620600)

Aaron J. Cole
Senior Fisheries Biologist
Wisconsin Department of Natural Resources
Northern Region – Barron
July, 2016

Executive Summary

Balsam Lake was surveyed in 2014 to assess the abundance and population demographics (i.e., size and age structure, growth, and recruitment) of sport fish and make comparisons with previous surveys. The adult walleye population estimate was 713 or 0.3 fish/acre (95% C.I. = 556-871), which is a decrease from the most recent survey in 2011 when the population estimate was 1,528 or 0.7 fish/acre (95% C.I. 1,210-1,847). The current walleye population estimate is the lowest on record and primarily consists of larger and older fish. The decrease in the walleye population occurred despite an extensive walleye stocking history. Large fingerling (6-8 in) walleye should continue to be stocked at a rate of 10 fish/acre on an alternate year basis. The largemouth bass population continues to be a high density and low size structure population with poor growth rates. Largemouth bass catch rates were high (72.4 fish/mile) during the late spring electrofishing survey. Largemouth bass in the 8 to 14-in length range were abundant. Largemouth bass comprised a large portion of the sport fishery during the 2014-2015 fishing season, in terms of catch and harvest. It was estimated that anglers harvested 5.7 bass/acre. Continued angler harvest of largemouth bass less than 14 in is recommended. If the largemouth bass population can be reduced, the size structure and growth rates of largemouth bass should improve. A lower bass population may also potentially improve walleye stocking success by reducing interspecific competition. Panfish continue to be an important component of the Balsam Lake fishery, as the majority of the angling effort on Balsam Lake is typically directed at panfish species. With the high density largemouth bass population, panfish populations should remain in good shape with many fish of desirable size.

Introduction

Balsam Lake is a 2,054 acre drainage lake located in central Polk County, in the Village of Balsam Lake, Wisconsin (Figure 1). The maximum depth is 37 feet and the lake has 22.7 miles of shoreline, nearly all of which is developed. Rice and Harder creeks are the tributary streams to Balsam Lake. There is an outlet at what is considered the "Mill Pond" on the south portion of the lake that forms the headwaters of the Balsam Branch. This outlet is controlled by a dam that is maintained by the Village of Balsam Lake. The dam raises the lake level by 33 feet.

Balsam Lake has a diverse fish community that is comprised of walleye *Sander vitreus*, northern pike *Esox lucius*, largemouth bass *Micropterus salmoides*, smallmouth bass *Micropterus dolomieu*, bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, pumpkinseed *Lepomis gibbosus*, green sunfish *Lepomis cyanellus*, yellow perch *Perca flavescens*, rock bass *Ambloplites rupestris*, warmouth *Lepomis gulosus*, white sucker *Catostomus commersoni*, and bullheads *Ameiurus spp*.

There has been an extensive history of fish stocking in Balsam Lake (Table 1). Walleye have been the most stocked species. Although walleye are not native to Balsam Lake (Becker 1983), they were first stocked in 1934. The Balsam Lake walleye fishery was sustained through natural reproduction after it was stocked, as there were only three walleye stockings from 1934 to 1976 (Cornelius 1986). The last naturally-reproduced walleye year-class that had a measurable contribution to the fishery occurred in 1985 (Cornelius 1989). Following several years of poor walleye year-classes, the walleye stocking program was reinitiated in 1986. These stockings consisted of fry and small fingerling (<3 in) stockings, but have since focused more on small fingerling and large fingerling (6-8 in) stockings.

Anglers have access to the lake by four public boat landings, and one public fishing pier. The base regulation for walleye in Balsam Lake is an 18-in minimum length limit (MLL) with a 3-fish daily bag limit. Largemouth and smallmouth bass have been managed under a variety of regulations in Balsam Lake. Beginning in 2002, the bass regulation allowed anglers to keep 5 bass with one bass less than 14 in, but the remainder had to be larger than 14 in. This regulation sunset in 2012 and it reverted back to the statewide 14 in MLL and five fish bag limit regulation. In spring 2014, the bass

regulation again changed to a no minimum length limit and five fish daily bag limit. Northern pike are protected with a 26 in MLL and two fish daily bag limit. All other species regulations follow the Wisconsin statewide fishing regulations.

Balsam Lake is considered a treaty trend lake, so it has been on a 3 year rotation for comprehensive surveys. Previous Wisconsin DNR fish surveys, which consisted of walleye population estimates, were conducted in 1987, 1988, 1994, 1998, 2002, 2005, 2008, and 2011. Historic fall electrofishing surveys from 1988-2014 were used to assess walleye stocking efficacy. During the most recent comprehensive survey report in 2008, the fishery was characterized by a lower density walleye population (P.E.= 1.0 adult fish/acre), an increasing largemouth bass population, a low abundance but high size structure northern pike population, and strong bluegill and black crappie populations that provided a majority of the recreational angling effort and harvest (Benike 2010). Management recommendations called for implementation of the 18-in MLL and 3 fish daily bag limit for walleye, focus walleye stocking on large fingerlings, change the bass regulation to a no minimum length limit and five fish daily bag limit in an attempt to reduce bass abundance.

The objectives of this survey were to assess the status of the walleye population as part of the treaty assessment sampling rotation of lakes for the Ceded Territory of Wisconsin and assess the abundance and population demographics (i.e., size and age structure, growth, and recruitment) of other sport fish in Balsam Lake and make comparisons with previous surveys.

Methods

Field Sampling:

The sport fishery in Balsam Lake was sampled in 2014 with early spring fyke netting, early spring and late spring electrofishing, and fall electrofishing (Table 2).

Population abundance of adult walleye was estimated using mark and recapture methodology during the early spring netting and early spring electrofishing surveys. Walleye were considered adult fish if they were ≥15 in or otherwise sexable (i.e., extrusion of eggs or milt; Cichosz 2013). Abundance of adult walleye was estimated

using Chapman's modification of the Petersen single-census method (Ricker 1975):

$$N = \frac{(M + 1)(C + 1)}{(R + 1)} - 1$$

where N = population estimate; M = the number of fish marked in the first (marking) sample; C = the total number of fish (marked and unmarked) captured in the second (recapture) sample; and R is the number of marked fish captured in the second sample.

Walleye were captured with fyke nets set at ice out. Fyke nets were set April 29, 2014 and checked every 24-h for 6 days. Fyke nets had 4 x 6 ft. frames, 0.5 to 0.75-in bar measure mesh, and lead lengths of 75 or 100 ft. All walleye collected in fyke nets were measured to the nearest 0.5-in TL and sexed; walleye were marked by clipping the left pelvic fin. Aging structures were collected from five walleye of each sex per 0.5-in length group. Scales were taken from walleye <12 in and dorsal spines were taken from fish ≥12.0 in. For the recapture period, walleye were collected by boat AC electrofishing along the entire shoreline of the lake with two dip netters at night. All walleye were measured, sexed, and checked for marks.

Largemouth bass and panfish were assessed by boat AC electrofishing at night along the shoreline on June 2-3, 2014 with two dip-netters. There were four 1.5-mile gamefish transects in which only gamefish were collected, and four 0.5-mile index transects in which all species were collected. Weights and aging structures were collected from five fish per 0.5-in length group for age and growth analysis. Otoliths, dorsal spines, and scales were collected from largemouth bass and scales were collected from all panfish species.

The year-class strength of age-0 walleye was assessed with fall boat AC electrofishing at night with two dip-netters. The entire shoreline was sampled and all walleye, largemouth bass, and northern pike were netted. Scale samples were collected from walleye <12 in. The catch per effort (CPE) of age-0 walleye and age-1 walleye was determined by catch per mile and compared to previous fall evaluations.

Population Demographics:

Scale samples were pressed on acetate slides and age was assessed on a microfiche reader by a single interpreter. Dorsal spines were mounted in plastic, cut with a Dremel saw and age interpreted on a microfiche reader by a single interpreter. Largemouth bass otoliths were mounted in epoxy, cut with a low speed saw, and aged by two interpreters. Mean length-at-age comparisons were made with previous surveys, the Barron and Polk County averages, and the regional (18 county WDNR Northern Region) averages obtained from the WDNR Fisheries and Habitat database.

The von Bertalanffy (1938) growth model was determined using mean length at age data to assess growth for walleye and largemouth bass using the following equation:

$$L_t = L_{inf}(1\text{-}e^{-k(t-t0)})$$

*Where L_t is length at time t, L_{inf} is the maximum theoretical length (length infinity), **e** is the exponent for natural logarithms, k is the growth coefficient, t is age in years, and t_0 is the age when L_t is zero.*

L_{inf} predicts the average ultimate length attained for fish in that population. Growth equations were calculated separately for each sex due to sex-specific growth differences.

Instantaneous mortality (Z) and annual mortality ($A = 1\text{-}e^{-Z}$) were estimated using a catch curve regression fitted to those ages fully recruited to the gear (Miranda and Bettoli 2007).

Proportional size distribution (PSD) indices were used to describe population size structure of walleye and largemouth bass (Guy et al. 2007). PSD values represent the percent of fish stock length or larger that are also larger also longer than a specified length (Appendix Table 1). The Fisheries Assessment Classification Tool (FACT) was used to determine how PSD values for largemouth bass and walleye compared to those from similar waterbodies throughout Wisconsin. In addition, the CPE for 8, 12, and 15 in (i.e., CPE8, CPE12, and CPE 15) largemouth bass were compared to similar waterbodies in Wisconsin. Relative Weight (*Wr*) was used to assess the condition level of largemouth bass using the standard weight equation (Anderson and Neumann 1996). Relative weight is the ratio of a fish's weight to the weight of a ''standard'' fish of the same length.

Recreational Creel and Tribal Harvest:

A year-round creel survey was completed on Balsam Lake to assess the effort and harvest from recreational anglers. The creel survey began the first Saturday in May and went to the first Sunday in March of the following year (i.e., the Wisconsin gamefish season). However, no creel data were collected during November because of unsafe ice conditions. The creel survey was separated into the open water fishing and ice fishing periods. Creel survey methods followed a stratified random design as described by Rasmussen et al. (1998). The directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish was evaluated for each species during the open water and ice fishing creel surveys. The angling exploitation rate for adult walleye was calculated by dividing the estimated number of marked adult walleye harvested by the total number of adult walleye marked (R/M; Ricker 1975). Tribal exploitation was calculated as the total number of adult walleye harvested divided by the adult population estimate (C/N; Ricker 1975). Total adult walleye exploitation rates were calculated by summing angling and tribal exploitation.

Results

Early spring fyke netting and electrofishing

Walleye. We fished up to 12 fyke nets for 6 nights, which totaled to 62 net-nights. The walleye catch rate was 6.9 fish/net-night. We collected 293 walleyes fyke netting (Figure 2), 292 of which were adults that received marks. There were 17 males, 275 females, and 1 immature walleye <15 in sampled.

There were 108 walleye collected during the early spring electrofishing (recapture period), for a catch rate of 4.6 fish/mile. The electrofishing sample included 5 recaptured males, 14 unmarked males, 38 recaptured females, and 51 unmarked females. The adult walleye population estimate was 713 or 0.3 fish/acre (95% C.I. = 556-871; Figure 3), which is a decrease from 2011 when it was estimated at 1,528 or 0.7 fish/acre (95% C.I. 1,210-1,847). The current walleye population estimate is the lowest recorded for Balsam Lake.

Size structure of walleye has increased in Balsam Lake. Walleye PSD from netting was 99 ± 1, PSD-P was 94 ± 3, and PSD-M was 37 ± 6 (Figure 4). These PSD

values are higher than previous netting surveys. When compared to statewide trends the indices were also high; walleye PSD was in the 91th percentile and PSD-P and PSD-M were both in the 100th percentile. The male: female ratio was 1:10. Mean length of walleye (sexes pooled) from fyke netting was 23.6 in. The mean length of male walleye was 19.1 in and the mean length of female walleye was 24.4 in.

Walleye in Balsam Lake had good growth rates. Mean length at age for walleye (sexes pooled) was greater than the Barron and Polk County average and the Northern Region average across all ages, and nearly all ages from previous surveys (Table 3). Mean length at age of female walleye was greater than male walleye across all ages (Figure 5). The predicted length infinity (L_{inf}) from the von Bertalanffy growth model was 27.3 in for female walleye, and 20.2 in for male walleye.

Walleye ages ranged from 2 to 12, male walleye ranged from age 2 to 10 and females ranged from 2 to 12. Most walleye collected were age 8 and age 10. The catch curve regression model was not able to estimate annual mortality.

Late spring electrofishing

Largemouth Bass. Largemouth bass were abundant and had low size structure. There were 579 largemouth bass collected during late spring electrofishing survey; the catch rate was 72.4 fish/mile or 175 fish/hour (Figures 6 & 7). These catch rates are slightly less than the 2008 survey (97.8 fish/mile; 223.4 fish /hour); but are greater than the catch rates of largemouth in all previous late spring electrofishing surveys. The catch rate of largemouth bass in Balsam Lake is also high when compared to similar waterbodies in Wisconsin. The CPE8, CPE12, and CPE15 were in the 96th, 93rd, and 64th percentiles, respectively.

Largemouth bass PSD was 45 ±4, and the PSD-P was 6 ±2, although the PSD and PSD-P have increased slightly since 2010, the general trend has been a decline in both indices since 1998 (Figure 8). The largemouth bass PSD was in the 22nd percentile for similar waterbodies in Wisconsin. Largemouth bass ranged in length from 4.8 to 19.8 in, and the mean length was 11.0 in. Largemouth bass *Wr* was 102, which suggests the largemouth bass were in average condition.

Growth rates of largemouth bass were less than the Barron and Polk County average and also the Northern Region average across all ages (Table 4). The mean length at age for bass were at an all-time low for nearly all ages when compared to previous surveys. Mean length at age of male and female largemouth were similar to age 8, and past age 8 female largemouth bass had greater average lengths (Figure 9). The predicted length infinity (L_{inf}) from the von Bertalanffy growth model was 20.2 in for female largemouth bass, and 15.9 in for male largemouth bass.

Largemouth bass were fairly long-lived. Ages of largemouth bass ranged from 2 to 17. The catch curve regression model (fitted to age 3 to age 17) estimated annual mortality to be 30.8% ($Z= -0.37$, $R^2 = 0.89$; Figure 10).

Smallmouth Bass. Smallmouth bass were not as abundant as largemouth bass in the late spring electrofishing sample. There were 19 smallmouth bass collected, which resulted in a catch rate of 2.4 fish/mile. Smallmouth bass ranged in length from 10.5 to 14.2, and the mean length was 11.5 in. All smallmouth bass collected were age 4 or age 5.

Bluegill. There were 340 bluegill collected during the late spring electrofishing survey (Figure 11). The catch was 170.0 fish/mile. Total length of bluegill ranged from 1.3 to 8.9 in, and the mean length was 5.7 in.

The size structure and growth rates of bluegill in Balsam Lake were fair. The PSD was 44 ± 5 and PSD-P was 2 ± 2. Bluegill growth was slightly less in the 2014 survey compared to the 2008 survey across all ages (Table 5). Mean length at age of bluegill in this survey was greater than the Barron and Polk County averages for ages 5 and older and greater than the northern Wisconsin average for ages 6 and older.

Other panfish. There were 40 pumpkinseeds sampled during the late spring electrofishing, for a catch rate of 20.0 fish/mile (Figure 12). The mean length was 6.4 in with a range of 4.0 to 7.9 in.

Twenty six rock bass were collected for a catch rate of 13.0 fish/mile. The mean length was 7.6 in with a range of 4.8 to 10.3 in.

Seven black crappies were collected which resulted in a catch per effort of 3.5 fish/mile. The mean length was 8.5 in with a range of 7.1 in to 9.9 in.

Six green sunfish were collected for a catch rate of 3 fish/mile. The mean length was 7.2 and there lengths ranged from 4.5 to 8.0 in.

There was one 6.8 in yellow perch collected for a catch rate of 0.5 fish/mile.

Fall Electrofishing

Age-0 walleye. There was no age-0 walleye collected during the fall electrofishing survey (Table 6). There were three age-1 walleye collected which resulted in a catch rate of 0.13 fish/mile. These fish were between 10.4 to 11.4 inches.

Catch rates of age-0 and age-1 walleye have historically been low in Balsam Lake, despite intensive stocking efforts. Catch rates of age-0 walleye have not exceeded 1.0 fish/mile. The highest catch rates of age-1 walleye were during years following a large fingerling stocking event (e.g., 2004 and 2006). Fry and small fingerling stockings have failed to produce measureable year-classes. Comparing fall catch rates of age-0 and age-1 walleye to walleye stocking indicates no consistent pattern of stronger year-classes during stocked years or in years with higher stocking rates. Although the Balsam Lake walleye fishery is stocking dependent, there is a negligible level of natural reproduction that occurs, as evidenced by the presence of age-0 walleye in non-stocked years and age-1 walleye the year following a non-stocked year.

Recreational Creel and Tribal Spearing

Open water angling effort amounted to 73,248 hours (35.7 hr/acre), which is slightly more than the 2008 and 2011creel surveys (Table 7). Ice angling effort amounted to 15,542 hours (7.6 hr/acre), which was less than the 2008 and 2011 creel surveys. The projected angling effort on Balsam Lake during the 2014-2015 fishing season was 88,790 hours (43.2 hr/acre), which is the least amount of fishing effort documented for Balsam Lake.

Walleye. The angler walleye harvest estimate was 44 fish (0.02/acre), which is the lowest harvest on record (Tables 8, 9, & 10). Fishing effort directed toward walleye accounted

for only 3.8% of the total effort during the open water, and 4.8% during the ice fishing season. Mean length of walleye harvested was 22.9 in during the open water season and 26.3 in during the ice fishing season. There was an additional 32 walleye harvested by tribal spearers. The recreational exploitation rate was 12.0%, and the tribal exploitation rate was 4.5%. Total annual walleye exploitation was 16.5%.

Largemouth bass. Largemouth bass comprised a large portion of the open water creel and the greatest amount of effort (33.4%) was directed toward them. Largemouth bass made up a smaller component of the ice fishing creel and received 17.9% of the angler effort. Projected annual catch and harvest of largemouth bass was high. We estimated that 103,472 largemouth bass (50.9 fish/ac) were caught of which 11,152 (5.7/ac) were harvested. The overall catch of bass was slightly less than 2011, but the harvest was significantly greater. An unprecedented number largemouth bass were harvested during the 2014-2015 season compared to previous creel surveys. The number of bass harvested per acre was 335% more than the average from all previous Balsam Lake creel surveys (1.7 fish/ac). The high harvest of bass is likely from the no minimum size limit and 5 fish bag limit on largemouth bass that was implemented at the start of the 2014 fishing season. This regulation enabled anglers to harvest largemouth bass that were previously protected. Of the largemouth bass harvested during this survey, 60.5% of them were less than 14 inches and would have been protected with the previous regulation (Figure 13). The mean length of largemouth bass harvested was 13.4 in during the open water creel and 13.8 in during the ice fishing creel.

Panfish. A considerable amount of angling effort was directed at panfish (bluegill, pumpkinseed, black crappie, and yellow perch). During the open water season, 56.2% of the total effort was directed towards panfish (Table 8). Of the total effort, bluegill were the most sought after (27.1%), followed by black crappie (19.1%), yellow perch (6.1%), and pumpkinseed (3.6%). Similarly, during the ice fishing creel survey 63.4% of the total effort was directed toward panfish (Table 9). Bluegill were most targeted by ice fishermen (35.5%), followed by black crappie (23.7%), and yellow perch (4.2%). Bluegill were the most caught and harvested species during the open water and ice

fishing creel seasons. The projected catch of bluegill was 130,243 (63.4/acre) which was similar to previous years; however, there were 48,883(23.8/acre) harvested, which is the second lowest on record (Table 10). The mean length of harvested bluegill was 7.9 in during the open water season and 8.0 in during the ice fishing season. Black crappie received a fair amount of effort. There were 48,014 black crappies (23.4/acre) estimated to be caught and 20,696 (10.1/acre) harvested. The mean length of black crappie harvested was 9.2 in during the open water season and 9.7 in during the ice fishing season. Although pumpkinseed and yellow perch represented a minor part of the overall fishery, they complimented the panfish opportunities in Balsam Lake. Both species were caught and harvested in lower numbers, but the mean length of harvested fish was of desirable size.

Northern Pike. Northern pike represented a small portion of the overall sport fishery. There were 9,049 northern pike (4.4/acre) estimated to be caught, but only 121 (0.1/acre) were harvested. The overall catch of northern pike appears to have increased since 2005, but the harvest is unchanged. Mean length of northern pike harvested was 28.2 in during the open water season and 26.9 in during the ice fishing season.

Summary and Discussion

Although Balsam Lake remains a popular fishing lake, the fish community has undergone several changes over the last three decades. Balsam Lake had a strong walleye fishery in the 1970s and 1980s where sufficient natural reproduction was able to sustain the population (Cornelius 1986). In 1989, the walleye population was estimated to be 3.4 adults/acre. However, without having any strong naturally-reproduced year-classes since 1985, and only limited stocking success (Cornelius 1996; Cornelius 2000), the population has steadily declined since 1989. The walleye population was found to be at an all-time low during this survey (0.3 fish/acre). Characteristics of the walleye population appear vastly different from those of the 2008 survey. The 2008 male:female sex ratio was 6.8:1; however, in this survey we found a sex ratio of 1:10 with the population mostly consisting of large female walleye. In general, there were few young walleye present in the population and the fishery was dominated by older (e.g., age 8 and

age 10) walleye, which is a contrast from the 2008 population that had well represented size and age distributions. The high size structure (and older) population that was documented in this survey is not a desirable walleye population. The 2004 and 2006 year-classes (age 8 and age 10) were the dominate year-classes in the fishery. If these year-classes move through the fishery (i.e., get harvested or succumb to natural mortality) without new recruitment, the walleye fishery will continue to decline.

The current decline in walleye population is driven by a lack of recruitment and not overharvest. Recreational angling and tribal spear harvest of walleye harvest has been minimal since 1988 and there has been minimal recruitment over that same period. This lack of recruitment has occurred despite extensive walleye stocking efforts with fry, small fingerlings, and low levels of large fingerlings. Of the 22 fall electrofishing surveys that have occurred since 1988, the mean catch rate of age-0 walleye has been 0.19 fish/mile. This is a very low catch rate, considering from 1990 to 2010 the average fall catch rate of age-0 walleye in the Ceded Territory was 31.7 fish/mile in naturally-reproducing populations and 5.7 fish/mile in stocked populations (Cichosz 2013). Similarly, the catch rate of age-1 walleye has been low during those same surveys (mean=0.37 fish/mile). The years that had the highest age-1 catch rates (i.e., 2005 and 2007) coincided with large fingerling stockings the previous year (2004 and 2006 year-classes).

The strongest year-classes present in this survey appear to have originated from large fingerling stockings. Only large fingerlings were stocked for the strongest year-class (2006), but large and small fingerlings were stocked for the 2010 year-class. Due to the lack of return on fry and small fingerling stockings, future stocking efforts should continue to focus on large fingerlings. Beginning in 2014, Balsam Lake was to receive large fingerling walleye at a rate of 10 fish/acre on an alternate year basis. However, for an unknown reason the lake did not get stocked at the full rate in 2014, but is expected to get the full amount in 2016. Hopefully the large fingerling walleye stocking regime will improve the adult walleye population in Balsam Lake; however, it is likely improbable for the walleye population to return to levels documented in the 1970s and 1980s (>3 adults/acre) unless the population contributes a measureable level of natural reproduction.

A more realistic goal for a stocked population would be to return to a density of 1.5-2 adults/acre.

Although the electrofishing catch per effort of largemouth bass was slightly less in this survey compared to 2011, the general trend has been an increasing bass population. The current population is characterized as having a high density, low size structure population. The mean length at age for bass in this survey declined for nearly all ages, which would suggest their density is increasing and their growth is slowing. However, the low mean length at age for bass in this survey may be an artifact of using otoliths, whereas previous surveys used scales and spines that tend to underestimate the true age. The largemouth bass aging dataset from otoliths in this survey is of high utility and should be used as a "pre-regulation" dataset that will be useful in detecting differences in mean length at age in the future. Otoliths provided us improved age estimates as well as sex-specific age and growth data. Otolith samples should be taken in approximately 10 years to monitor the age, growth, and mortality rates of largemouth bass following implementation of the no minimum length limit.

It was evident in this survey that Balsam Lake anglers are willing to harvest bass. Anglers are encouraged to continue to harvest largemouth bass, especially those less than 14 in. If the largemouth bass population can be reduced, the size structure and growth rates of largemouth bass should improve. A lower bass population may also potentially improve walleye stocking success, by reducing interspecific competition.

Balsam Lake has long had a reputation as a good panfish lake, which continues to be the case. With the high density largemouth bass population, panfish populations should remain in good shape with many fish of desirable size. Panfish are an important component of the Balsam Lake fishery, as the majority of the angling effort on Balsam Lake is typically directed at panfish species. Typically angler effort toward panfish species exceeds 50% of the total effort on Balsam Lake, and most of this effort is directed toward bluegill and crappie.

Balsam Lake has historically had a low density northern pike population. Northern pike appear to remain at a low density, but their abundance may have increased slightly due do the increased catch observed in the creel survey. A more thorough review of the northern pike population is recommended in future surveys.

Management Recommendations

1. Maintain the walleye density between 1.5-2 fish/acre through stocking large fingerling (6-8 in) walleye at a rate of 10 fish/acre. A better assessment will be made on the relative contribution of the large fingerlings during the annual fall electrofishing surveys and comprehensive surveys.
2. Fry and small fingerling walleye stocking efforts should be discontinued due to the poor return from stocking those size classes.
3. If the adult walleye population declines further or evidence suggests that extended growth fingerlings are not surviving, more restrictive angler regulations should be considered (28 inch minimum length limit, 1 fish daily bag limit) along with discussions with the TWG about potential tribal adjustments.
4. Maintain the no minimum length limit and five fish daily bag limit bass regulation and encourage continued harvest of largemouth bass less than 14 inches. Reducing the number of small largemouth bass should increase the size structure and growth rates of the population and may improve walleye stocking success.
5. Continue to monitor the abundance, size structure, and growth rates of the largemouth bass population during fall electrofishing surveys and comprehensive surveys. Another otolith sample should be taken in 2023 to assess any changes in the age, growth, and mortality of the largemouth bass population.
6. Maintain the current angling regulations for northern pike.
7. Encourage lakeshore property owners to minimize disturbance to the lakeshore and littoral zone to protect fish and wildlife habitat, and water quality
8. Continue invasive species education, monitoring, and prevention activities

Acknowledgements

Special thanks are extended to the Brian Spangler and Josh Kucko of the Barron field office with assistance in the field, data entry, and fish age estimation, as well as the staff with the Spooner treaty assessment unit, especially Gene Hatzenbeler, Misty Rood, Todd Brecka, Jill Sunderland, and Marty Kangas for data collection, data entry, and completion of the creel survey.

Literature Cited

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447–482 *in* B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.

Benike, H. M. 2010. Balsam Lake Treaty Assessment Survey, Polk County Wisconsin, 2008-2009, (MWBIC: 2620600) Wisconsin Department of Natural Resources, Internal Fisheries Management Report. Barron Field Office.

Cichosz, T. A. 2013. Wisconsin Department of Natural Resources 2011-2012 Ceded Territory Fishery Assessment Report. Administrative Report No. 73 Wisconsin Department of Natural Resources, Madison.

Cornelius, R. R. 1986. Fish Survey, Balsam Lake (2620600), Polk Co.– 1985. Wisconsin DNR memo. January 13, 1986.

Cornelius, R. R. 1989. Fish Survey, Balsam Lake (2620600), Polk Co. – 1987-1988. Wisconsin DNR memo. April 17, 1989.

Cornelius, R. R. 2000. Fish Survey, Balsam Lake (2620600), Polk Co. – 1998. Wisconsin DNR memo. January 25, 2000.

Guy, C. S., R. M., Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution: a further refinement of population size structure index terminology. Fisheries 32(7):348.

Miranda L. E., and P. W. Bettoli. 2007. Mortality. Pages 229–277 in C. S. Guy and M. R. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Rasmussen, P. W., M. D. Staggs, T. D. Beard, Jr., and S. P. Newman. 1998. Bias and confidence interval coverage of creel survey estimators evaluated by simulation. Transactions of the American Fisheries Society 127:469-480.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Human Biology 10: 181–213.

Table 1. Stocking history for Balsam Lake, Polk County, WI, 1986-2014.

Stocking Year	Species Name	Size	Number Stocked
1975	Walleye	Fry	2,900,000
1976	Walleye	Small Fingerling	82,600
1976	Walleye	Fry	2,000,000
1977	Walleye	Fry	1,792,000
1978	Walleye	Fry	960,000
1979	Walleye	Fry	992,000
1981	Walleye	Fry	1,314,540
1986	Walleye	Small Fingerling	65,009
1987	Walleye	Small Fingerling	132,174
1988	Walleye	Fry	2,054,000
1988	Walleye	Small Fingerling	86,110
1989	Largemouth Bass	Small Fingerling	11,000
1989	Walleye	Fry	2,054,000
1989	Walleye	Small Fingerling	98,494
1990	Walleye	Fry	2,054,000
1990	Walleye	Small Fingerling	107,172
1991	Walleye	Fry	2,054,000
1991	Walleye	Small Fingerling	49,981
1992	Walleye	Small Fingerling	155,614
1993	Walleye	Yearling	2,079
1994	Walleye	Small Fingerling	157,181
1996	Walleye	Fry	40,618
1996	Walleye	Small Fingerling	52,921
1998	Walleye	Large Fingerling	29,445
1998	Walleye	Small Fingerling	186,953
2000	Walleye	Small Fingerling	231,849
2002	Walleye	Large Fingerling	106
2002	Walleye	Small Fingerling	309,197
2004	Walleye	Large Fingerling	18,853
2004	Walleye	Small Fingerling	42,695
2006	Walleye	Large Fingerling	20,538
2008	Walleye	Small Fingerling	108,375
2010	Walleye	Small Fingerling	41,264
2012	Walleye	Small Fingerling	93,480
2014	Walleye	Large Fingerling	1,912

Table 2. Sampling effort for the 2014 Balsam Lake comprehensive fisheries survey.

Date	Gear	Survey type	Effort
Apr 29, 2014 to May 5, 2014	Fyke nets	Walleye netting	62 net nights
May 5, 2014	Electrofishing	Walleye recapture	23.4 miles
June 2, 2014 to June 3, 2014	Electrofishing	Bass-Panfish electrofishing	8.0 miles
Oct. 1, 2014	Electrofishing	Age-0 walleye electrofishing	22.7 miles

Table 3. Mean length (in) at age for walleye (sexes pooled) in Balsam Lake, 1988-2014, the Barron and Polk County average, and the northern Wisconsin (NOR) average.

Age	1988	1994	1998	2002	2005	2011	2014	Barron & Polk	NOR
1	7.6	6.6	—	—	—	—	—	7.5	6.4
2	10.7	10.0	10.5	10.8	11.4	—	11.5	10.9	9.5
3	13.3	12.7	13.1	13.1	13.0	14.5	—	13.9	11.7
4	15.4	16.5	15.7	16.4	15.2	—	19.0	15.6	13.8
5	19.0	17.3	18.3	19.4	17.8	19.3	19.5	17.8	15.8
6	19.3	18.9	20.4	19.4	19.2	18.2	20.3	19.0	17.5
7	19.9	20.0	21.2	22.7	20.8	20.8	—	20.8	19.1
8	21.6	22.1	21.8	22.1	21.4	19.1	24.2	21.8	20.5
9	23.1	21.8	23.1	25.5	23.6	22.1	—	22.5	21.6
10	22.5	23.7	22.9	24.3	24.6	—	25.2	23.3	22.7
11	26.7	25.1	23.5	—	24.3	23.3	—	23.9	23.7
12	25.9	27.3	24.5	27.2	24.6		27.5	25.1	24.4
13	29.1	26.6	26.1	—	25.4	26.5	—	25.2	25.2
14	28.0	28.2	25.3	24.7	—	—	—	24.8	25.8
15	—	28.2	28.3	—	—	28.2	—	25.6	25.6
16	26.0	—	26.4	22.3	—	—	—	25.2	25.6
17	—	29.0	29.2	—	21.4	28.5	—	27.0	25.2
18	—	—	28.5	28.0	—	—	—	25.5	25.6

Table 4. Mean length (in) at age for largemouth bass in Balsam Lake, from 1998-2014, the Barron and Polk County average, and the northern Wisconsin average.

Age	1998	2002	2005	2008	2014	Barron & Polk	NOR
1	—	—	—	4.2	—	4.2	4.7
2	6.7	6.1	6.8	6.5	5.8	6.8	6.7
3	8.6	8.1	9.2	8.2	7.5	8.9	9.0
4	10.4	11.2	11.5	9.9	10.0	10.9	11.0
5	12.6	13.3	12.8	11.4	11.2	12.5	12.7
6	13.8	14.4	13.2	12.6	12.2	13.9	14.6
7	15.4	15.7	14.7	13.9	12.9	14.9	16.0
8	15.6	16.0	15.1	15.4	13.6	16.0	17.3
9	17.8	16.9	15.7	16.1	14.5	17.0	18.1
10	18.2	16.7	16.3	16.8	14.9	17.5	18.8
11	19.4	17.2	17.3	18.1	15.3	18.5	19.4
12	18.9	18.5	17.7	18.4	13.5	18.7	19.6
13	20.2	—	17.9	—	16.8	19.4	19.4
14	—	—	17.9	—	15.0	19.7	20.2
15	—	—	19.2	—	14.7	20.0	21.0
16	—	—	19.5	—	18.5	20.6	—
17	—	—	19.1	—	17.3	19.1	—

Table 5. Mean length (in) at age for bluegill in Balsam Lake, from the 2008 and 2014 comprehensive surveys, the Barron and Polk County average, and the northern Wisconsin average.

Age	2008	2014	Barron & Polk	NOR
1	—	1.5	2.3	2.4
2	3.2	2.5	3.4	3.7
3	4.4	3.2	4.3	4.7
4	5.5	4.8	5.4	5.6
5	6.6	6.3	6.2	6.5
6	7.8	7.5	6.9	7.1
7	8.4	8.0	7.4	7.7
8	—	8.9	7.8	8.2
9	—	—	8.4	8.8

Table 6. Fall electrofishing catch rates of age-0 and age-1 walleye in Balsam Lake with walleye stocking history. An asterisk denotes a non-stocked year. A hyphen denotes a non-sampled year. Sampling occurred prior to stocking in 2004, 2006, and 2014.

Stocking Year	Size Stocked	Number Stocked	Age-0 / mile	Age-1 / mile
1988	Small Fingerling	86,110	0.10	
1989	Small Fingerling	98,494	—	—
1990	Small Fingerling	107,172	0.30	
1991	Small Fingerling	49,981	0.30	0.30
1992	Small Fingerling	138,340	0.30	0
1993	*	*	0.00	0.00
1994	Small Fingerling	157,181	0.88	0.00
1995	*	*	—	—
1996	Fry	40,618	—	—
	Small Fingerling	52,921		
1997	*	*	—	—
1998	Large Fingerling	29,445	0.70	0.31
	Small Fingerling	186,953		
1999	*	*	—	—
2000	Small Fingerling	231,849	—	—
2001	*	*	0.00	0.22
2002	Large Fingerling	106	0.09	0.00
	Small Fingerling	309,197		
2003	*	*	0.04	0.62
2004	Large Fingerling	18,853	0.97	0.18
	Small Fingerling	42,695		
2005	*	*	0.00	3.04
2006	Large Fingerling	20,538	0.04	0.53
2007	*	*	0.00	1.37
2008	Small Fingerling	108,375	0.00	0.44
2009	*	*	0.00	0.09
2010	Small Fingerling	41,264	0.00	0.00
2011	*	*	0.00	0.04
2012	Small Fingerling	93,480	0.35	0.00
2013	*	*	0.00	0.04
2014	Large Fingerling	1,912	0.00	0.13

"*" Denotes non-stocked year

"—" Denotes no sampling

Table 7. Recreational creel survey total angling effort and effort per acre for Balsam Lake, Polk County, WI, 1987-2014.

	Open Water Fishing		Ice Fishing		Entire Season	
Year	Hours	Hours/acre	Hours	Hours/acre	Hours	Hours/acre
1987	148,020	72.1	23,648	11.5	171,668	83.6
1988	118,230	57.6	8,092	3.9	126,322	61.5
1994	90,516	44.1	10,869	5.3	101,385	49.4
1998	86,379	42.1	8,742	4.3	95,121	46.3
2002	97,050	47.2	22,830	11.1	119,880	58.4
2005	85,669	41.7	10,201	5.0	95,870	46.7
2008	70,973	34.6	25,783	12.6	96,756	47.1
2011	66,424	32.3	26,022	12.7	92,446	45.0
2014	73,248	35.7	15,542	7.6	88,790	43.2

Table 8. Directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish by species during the 2014-2015 Balsam Lake open water creel survey.

Species	Directed Effort (Hours)	(%)	Catch	Harvest	Harvest/Hour	Mean Length (inches)
Largemouth Bass	35,886	33.4%	103,472	11,152	0.31	13.4
Bluegill	29,095	27.1%	108,602	40,020	1.38	7.9
Black Crappie	20,848	19.4%	41,680	17,282	0.83	9.2
Yellow Perch	6,543	6.1%	5,344	1,578	0.24	9.2
Northern Pike	5,767	5.4%	8,775	101	0.02	28.2
Walleye	4,107	3.8%	228	20	0.00	22.9
Pumpkinseed	3,851	3.6%	2,977	1,561	0.41	7.4
Smallmouth Bass	1,358	1.3%	1,242	83	0.06	13.4
Rock Bass	__	__	11,672	507	__	8.5
Green Sunfish	__	__	102	102	__	7.7

Table 9. Directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish by species during the 2014-2015 Balsam Lake ice fishing creel survey.

Species	Directed Effort (Hours)	(%)	Catch	Harvest	Harvest/Hour	Mean Length (inches)
Bluegill	7,697	35.5%	21,641	8,813	1.15	8.0
Black Crappie	5,138	23.7%	6,334	3414	0.66	9.7
Largemouth Bass	3,873	17.9%	1,132	509	0.13	13.8
Northern Pike	3,015	13.9%	274	20	0.01	26.9
Walleye	1,044	4.8%	61	24	0.02	26.3
Yellow Perch	904	4.2%	1489	429	0.47	9.7
Pumpkinseed	—	—	358	149	—	7.6
Rock Bass	—	—	50	0	—	—

Table 10. Estimated catch/acre and harvest/acre (in parentheses) of sportfish by angling, Balsam Lake, Polk County, WI, 1987-2014.

	Species								
Year	Largemouth Bass	Walleye	Northern Pike	Bluegill	Black Crappie	Yellow Perch	Pumpkinseed	Smallmouth Bass	Rock Bass
1987	13.0 (2.4)	5.7 (1.5)	1.0 (0.6)	148.7 (90.7)	34.3 (20.8)	4.9 (0.6)	—	—	—
1988	10.5 (2.2)	2.9 (1.1)	0.3 (0.2)	109.0 (100.1)	11.7 (10.7)	—	—	—	—
1994	23.7 (0.8)	0.3 (0.1)	2.0 (0.3)	71.3 (30.7)	6.8 (4.2)	15.0 (3.9)	1.8 (1.1)	—	—
1998	24.3 (1.7)	1.4 (0.3)	3.7 (0.1)	29.9 (10.8)	12.8 (8.0)	1.6 (0.1)	0.4 (0.3)	—	—
2002	35.2 (2.3)	0.8 (0.2)	3.2 (0.2)	98.6 (37.7)	18.0 (9.4)	5.2 (1.3)	2.2 (0.8)	—	6.5 (0.7
2005	26.4 (1.0)	0.3 (0.0)	2.2 (0.1)	78.8 (33.6)	25.9 (17.1)	5.1 (1.6)	1.8 (0.8)	0.3 (0.0)	6.5 (0.6)
2008	33.6 (1.2)	1.2 (0.1)	2.2 (0.1)	68.0 (31.6)	32.1 (15.4)	4.6 (1.5)	1.4 (0.5)	0.1 (0.0)	—
2011	69.8 (2.3)	0.4 (0.3)	3.6 (0.1)	53.7 (30.7)	8.8 (5.5)	6.3 (1.5)	0.7 (0.4)	0.2 (0)	0.6 (0)
2014	50.9 (5.7)	0.1 (0)	4.4 (0.1)	63.4 (23.8)	23.4 (10.1)	3.3 (1.0)	1.6 (0.8)	0.6 (0.0)	5.7 (0.2)

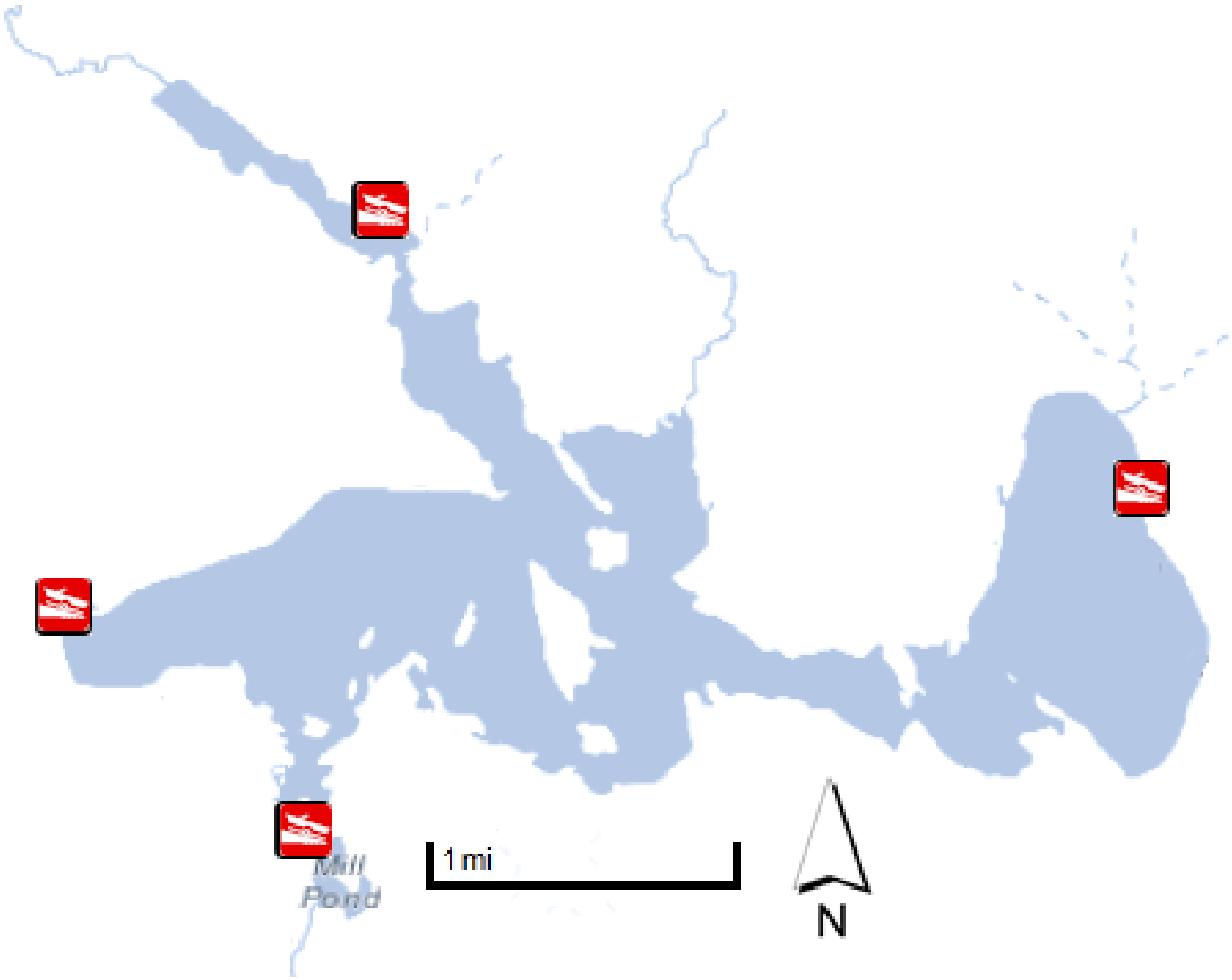

Figure 1. Map of Balsam Lake, Polk County, Wisconsin.

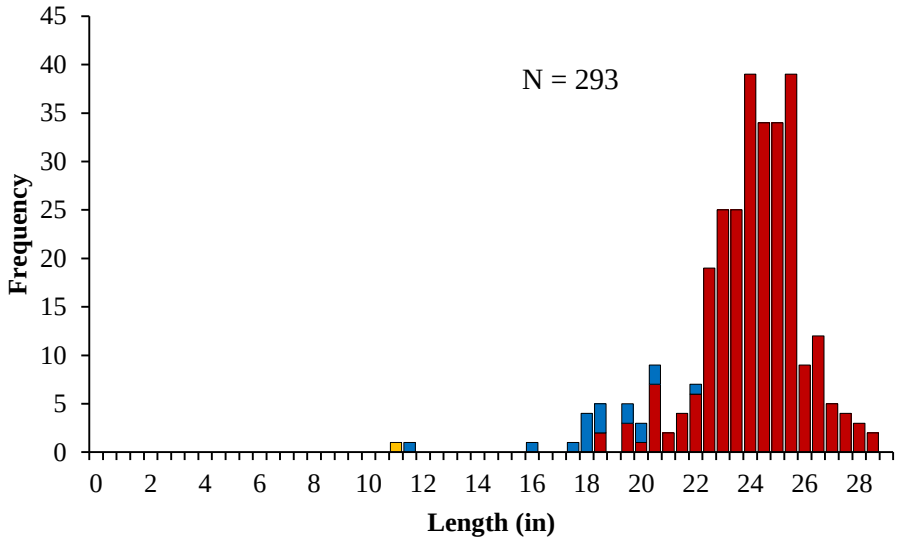

Figure 2. Length frequency histogram for walleye captured with fyke nets in Balsam Lake, Polk County, WI, 2014. Orange bars represent walleye of unknown sex, blue bars represent male walleye, and red bars represent female walleye.

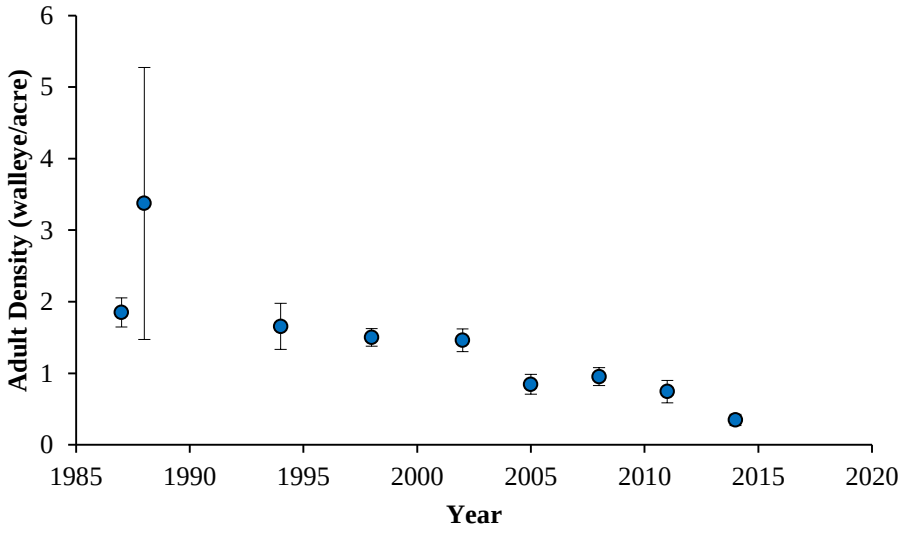

Figure 3. Population estimates for adult walleye (with 95% confidence intervals) in Balsam Lake, Polk County, WI, 1987-2014.

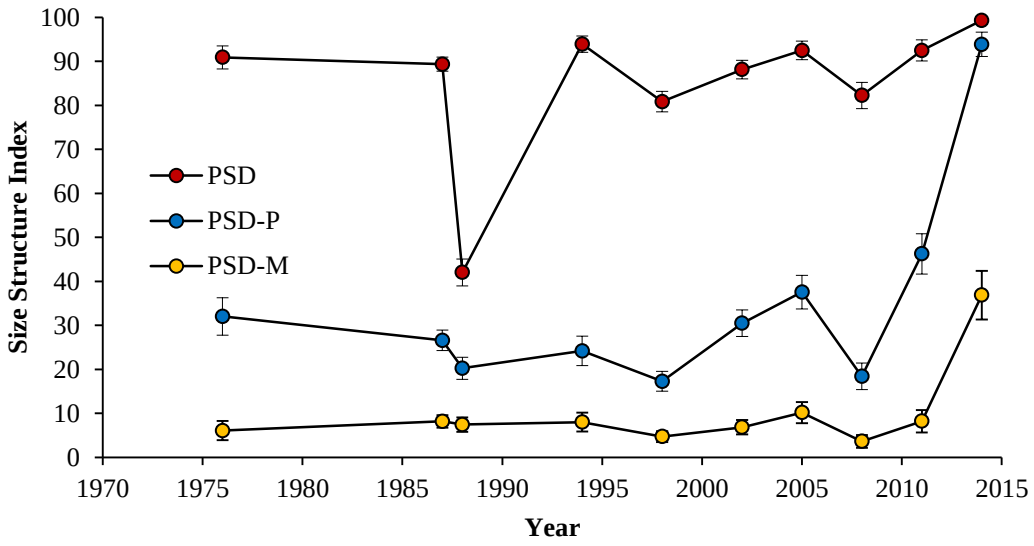

Figure 4. PSD, PSD-P, and PSD-M size structure index values (with 95% confidence intervals) for walleye collected from fyke nets in Balsam Lake, Polk County, WI, 1976-2014.

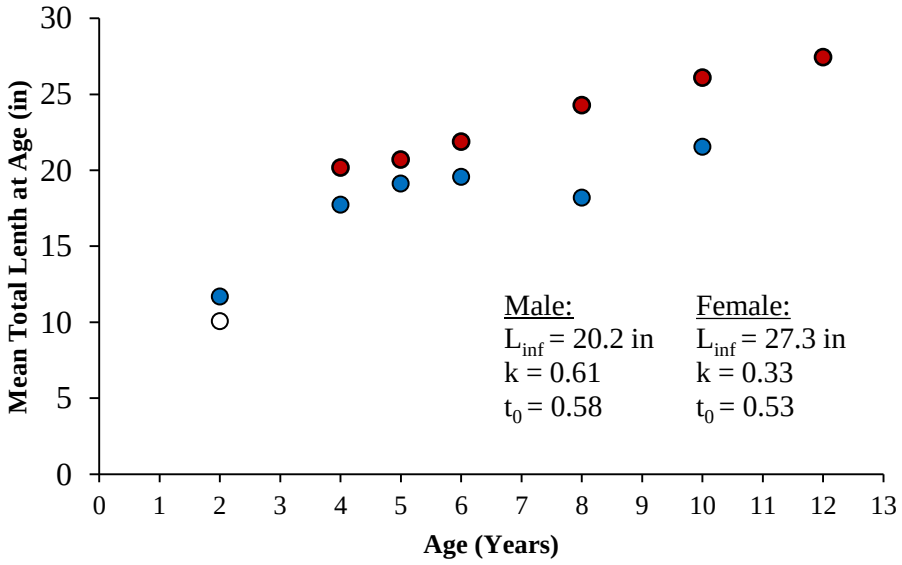

Figure 5. Mean lengths at age for female (red circles), male (blue circles), and unknown sex (open circles) walleye collected from Balsam Lake, Polk County, WI, 2014. Mean length at age of age-2 unknown sex walleye were included for the female growth equation. L_{inf} = theoretical maximum length, k = growth coefficient, and t_0 = time at which length is zero.

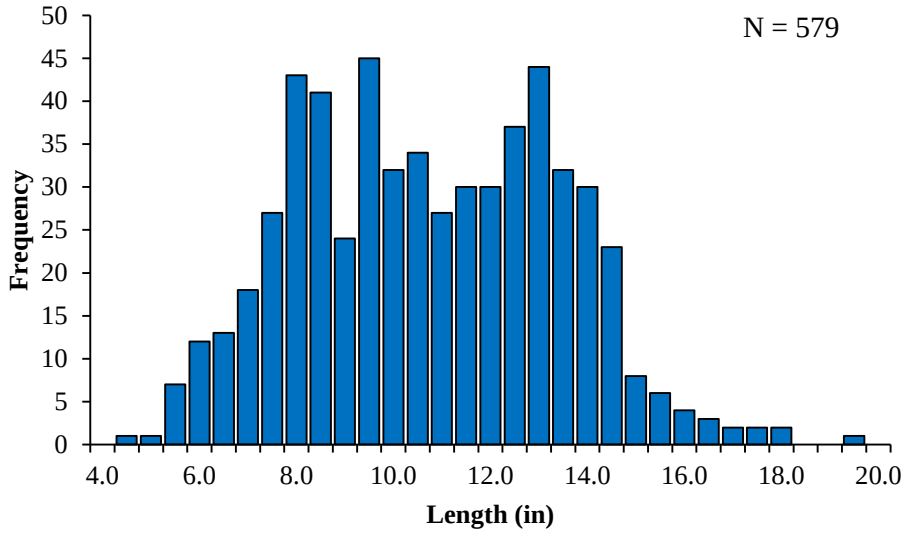

Figure 6. Length frequency histogram for largemouth bass captured in the late spring electrofishing in Balsam Lake, Polk County, WI, 2014.

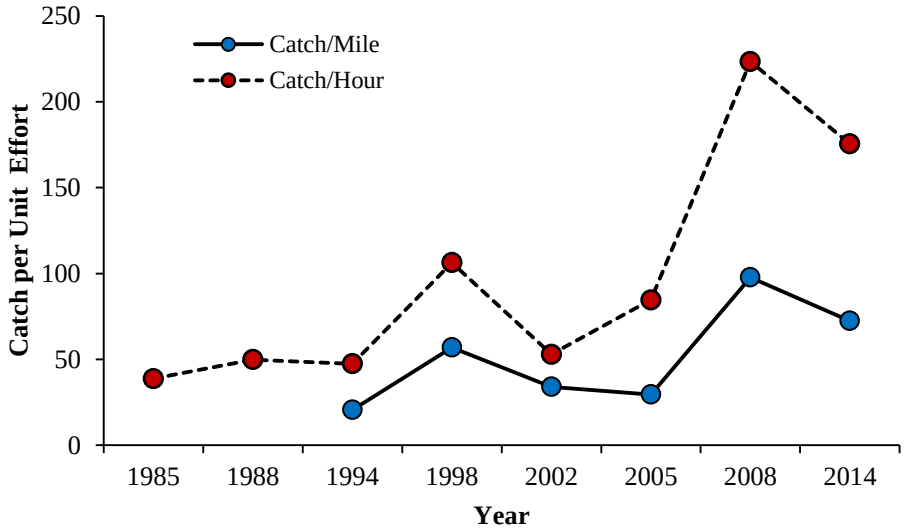

Figure 7. Catch per effort for largemouth bass collected during late spring electrofishing surveys from Balsam Lake, Polk County, WI, 1985-2014.

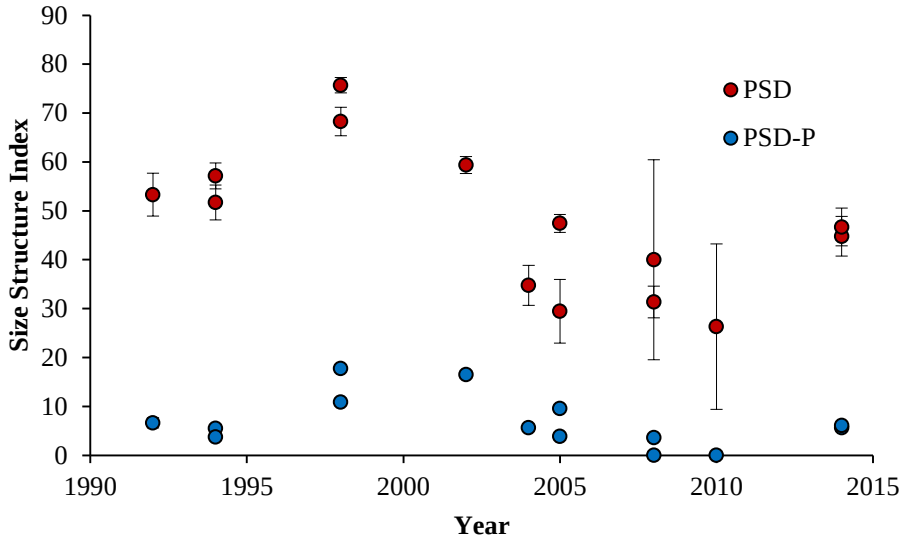

Figure 8. PSD (red circles) and PSD-P (blue circles) size structure index values (with 95% confidence intervals) for largemouth bass collected electrofishing in Balsam Lake, Polk County, WI, 1992-2014.

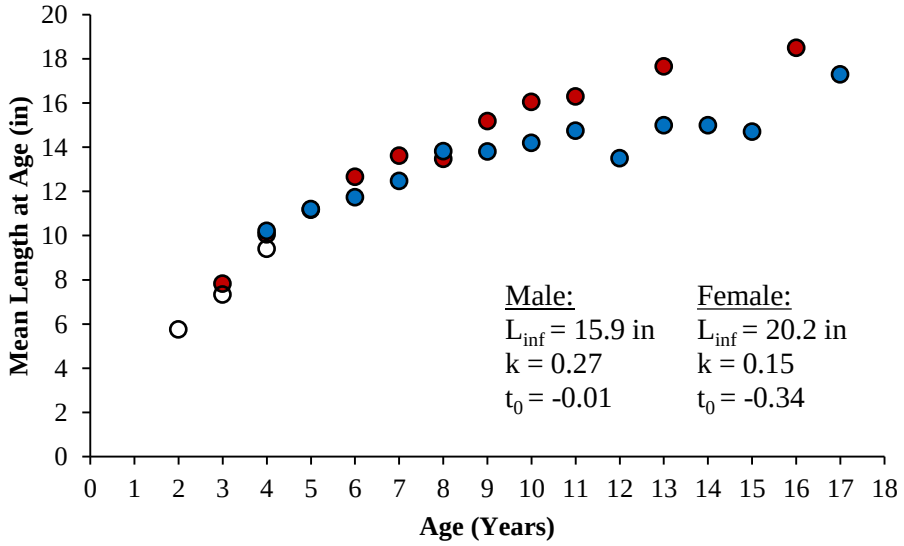

Figure 9. Mean lengths-at-age for female (red circles), male (blue circles), and unknown sex (open circles) largemouth bass collected from Balsam Lake, Polk County, WI, 2014. Mean length at age of age-2 to age-3 unknown sex largemouth bass were included for the growth equations. L_{inf} = theoretical maximum length, k = growth coefficient, and t_0 = time at which length is zero.

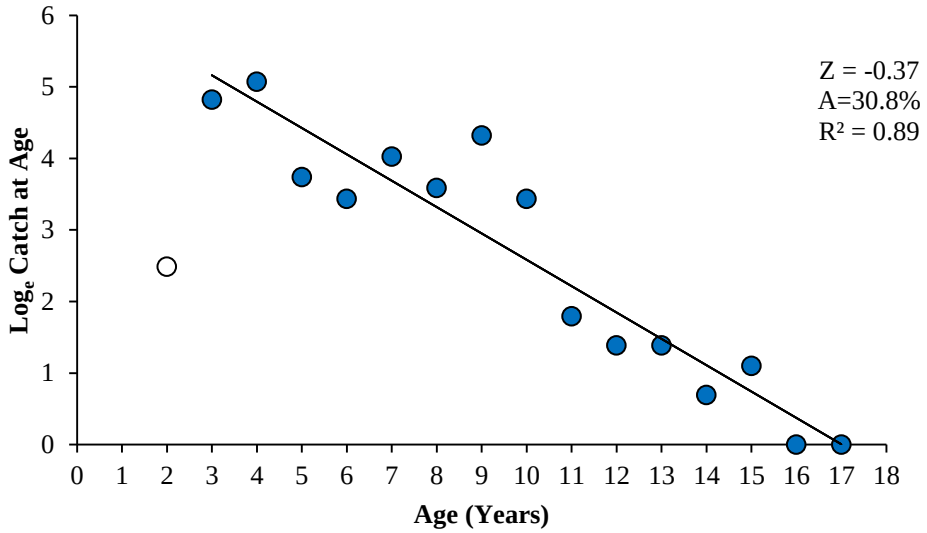

Figure 10. Number at age for largemouth bass collected from Balsam Lake, Polk County, WI in 2014. A catch-curve regression estimated instantaneous annual mortality (Z) and total annual mortality (A). Age-2 was omitted from the regression.

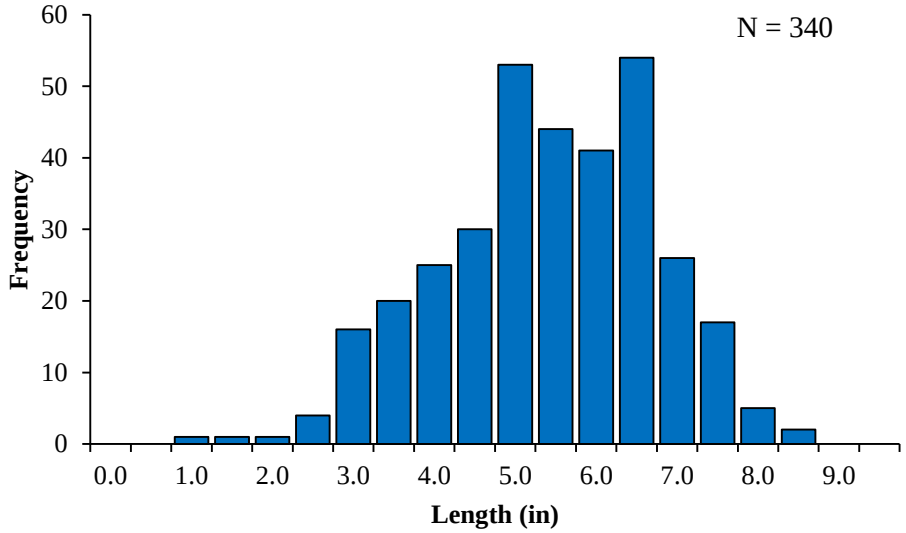

Figure 11. Length frequency histogram for bluegill captured in the late spring electrofishing in Balsam Lake, Polk County, WI during 2014.

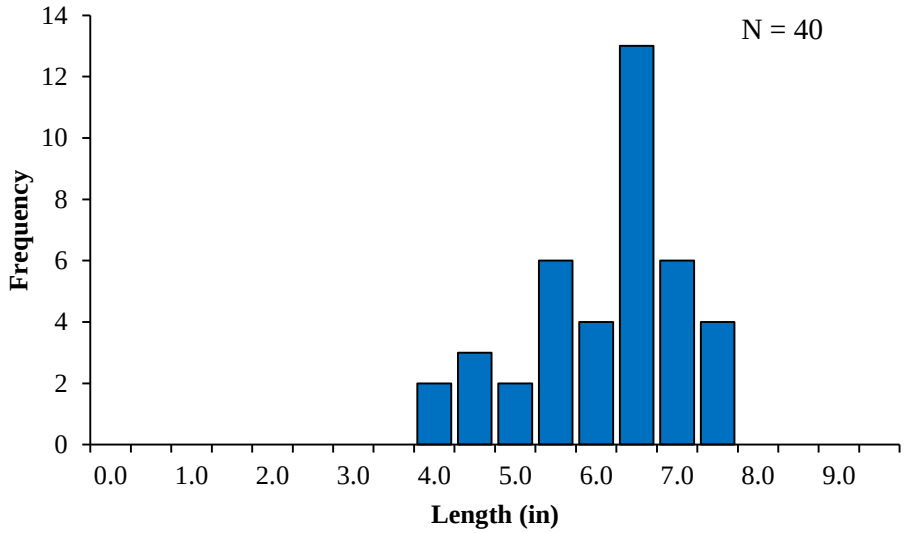

Figure 12. Length frequency histogram for pumpkinseed captured in the late spring electrofishing in Balsam Lake, Polk County, WI during 2014.

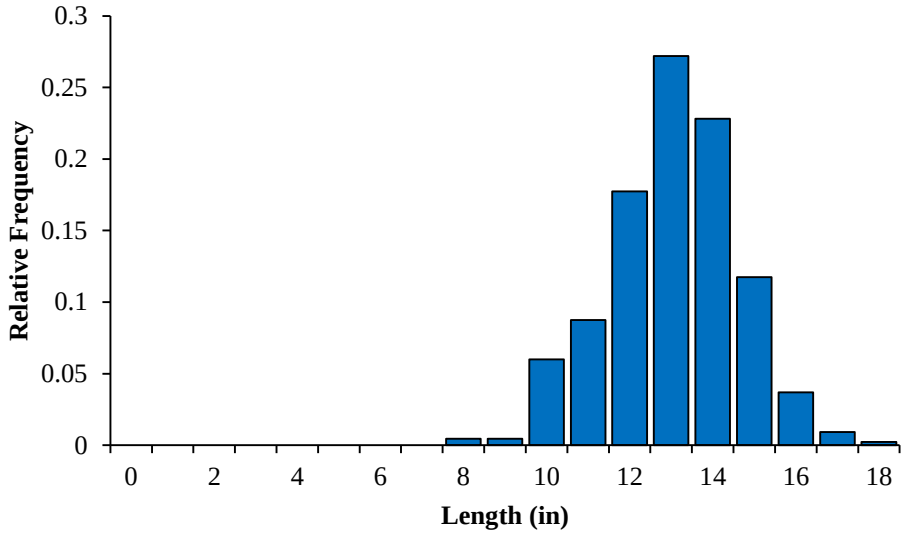

Figure 13. Relative frequency histogram of largemouth bass harvested from Balsam Lake, Polk County 2014-2015.

Appendix 1. Lengths (in) used in proportional size distribution (PSD) indices for stock, quality, preferred, and memorable-sized largemouth bass and walleye.

Fish Species	Stock	Quality	Preferred	Memorable
Largemouth bass	8	12	15	—
Walleye	10	15	20	25